THE ROLE OF STANDARDS IN LOWER-COST DIGITAL SPACECRAFT AVIONICS

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Abstract

The usc of standard interfaces could result in large savings for the aerospace industry. This paper discusses the philosophy, applicability, and implications of using interface standards in spacecraft applications. It is argued that, while there are some negatives associated with their use, standards should be liberally applied to all aspects of spacecraft avionics because they ultimately reduce end-to-end system costs.

Interface Standards

There are many standards but, from an architectural perspective, we are generally concerned only with those standards which specify how objects interact with the world -- *interface standards*. Standards which specify how objects look internally (component standards) or how objects are made (process standards) arc of less interest to the systems architect. The interaction of the members of a complex system depends on their interfaces, not their internal details. Interface standards include electrical, protocol, language, and environmental specifications. Further discussion of standards in this document is focused solely on interface standards and, hereinafter, "standard" should be so understood although some comments may apply to other types of standards.

The specification and use of interface standards is important because they are the most relevant from a systems procurement perspective. Further, the selection and subsequent use of a small number of interface standards can allow space product vendors to focus their efforts and thus reduce costs. While interface standards freeze technology at component (or assembly or subassembly) boundaries, this freeze allows technology evolution within a product line without adversely affecting the outside world.

Component standards and process standards are more likely to stifle change. Moreover, a component which conforms to standard-interfaces will have all the desirable properties of a "standard component" without overly constraining its manufacture.

Standards may be divided into three subclasses according to their maturity: existing (mature) standards, emerging standards, and new standards. Existing, mature standards have immediate value; products exist, are well-understood and are supported. A project which can specify such a standard can benefit immediately with specification, design, and procurement savings. The specification of emerging standards by a procuring organization allows vendors to perceive a long-term benefit in their proposal efforts; while cost reductions may not immediately be visible, they are li kely after the second or third procurement. New standards should be pursued only when their development can be clearly justified both by lack of existing (or emerging) standards and by the anticipation of multiple future uses.

It is possible to specify one interface of an object without specifying all of its interfaces. Screw threads were standardized long ago (SAE J475a / ANSI B 1,1). A mechanical drawing calling out a 4-40 screw implies a particular interface between the screw and its threaded mate. However, it says nothing about the interface with the driver; the specification of socket head or Phillips head is independent of the thread specification. (Note that even the combination of thread and head type still only constitutes an interface specification, not a standard component. A standard component would further specify the material and the surface finish so that anyone would know precisely what the component was.)

Why Use Standard Interfaces?

The only purpose for using standards is to reduce costs; if cost were no object, any other figure of merit can be improved relative a given standard, The most to be an intermediate language between compilers and low-level interpreters. C is **today's P-code.** Many compilers emit it (lex, yacc, C++, Synopsis, I-logix, etc.) and many interpreters understand it (the C compilers themselves).

Negatives of Standards

Standards have some negatives. A common concern is that standards may inhibit technology growth; however, as we have seen, their use may actually allow more rapid evolution. The use of overly generic functionality may degrade performance relative to custom solutions. Components implementing the "extra" functionality of a standard may consume more power. The additional functionality will often cause early products conforming to a standard to cost more. Cost reductions are only realized through the use of a particular standard if more than one system uses it.

The use of standards may not make sense if

With fixed-price and base-plus-incentive contracts, it is no longer possible for contractors to make a profit regardless of approach. In this new marketplace, the use of standards allows more cost-effective solutions to problems. There is no evidence that the aerospace industry market is too small to support standards. In fact, the opposite is more likely true; the industry is too small not to support standards.

Selecting and Using Standards

Whether to Use a Standard

Some common attitudes about standards usage for spacecraft electronics interfaces are captured by the following quotes:

> "Remember that using any standard will cost you more power."

makes no sense to select a standard and then allow contractors (or employees) to violate it, proliferate new standards, or design custom solutions.

Superficially, it would appear that there is no difference between a small company's requirement to use a particular standard and the Federal government's. Each is trying to accomplish the same goals -- compatibility, maintainability, interoperability, etc. The fundamental difference between the two is their size. The purchases by a small company is one vote among many peers whose aggregate purchasing distribution determines which standards survive and which fail. But Federal spending constitutes 35% of the GNP and a Federal mandate is tantamount to monopolistic trade practices. Effectively, Ada is a proprietary standard; the Federal government (DoD)

Compatibility and Conformance with Standards

As an example of a pervasive mind-set, consider the following comment made by an engineer during an actual study:

> "Currently, we are baselining a stripped-down version of the 1553 protocol . . . which can be implemented using an FPGA and RS485 transceivers . . . The 1553 protocol will be stripped of all the bells-and-whistles which are unnecessary so that we can have a simple implementation within an FPGA. Examples of bells-and-whistles that are not needed in the protocol are RT-RT transfers, RT broadcasts, etc. Slight modifications to the protocol may also lead to improvements in the data rate..."